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# System-Size Dependence of Strangeness Saturation.

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**Abstract.** The final state in heavy-ion collisions has a higher degree of strangeness saturation than the one produced in collisions between elementary particles like $p-p$ or $p-\bar{p}$. A systematic analysis of this phenomenon is made for $C-C$, $Si-Si$ and $Pb-Pb$ collisions at the CERN SPS collider and for $Au-Au$ collisions at RHIC and at AGS energies. Strangeness saturation is shown to increase smoothly with the number of participants at AGS, CERN and RHIC energies.

Statistical-thermal models are able to fit the multiplicities measured in relativistic heavy-ion collisions with remarkable success [1, 2, 3, 4]. A striking feature is that the freeze-out temperatures observed in $p-p$, $p-\bar{p}$ and in relativistic heavy-ion collisions are similar but the strangeness saturation is very different. In this paper we investigate this difference and determine the thermal parameters as a function of the number of participants. We conclude that the strangeness saturation increases smoothly with the size of the system at all energies [5, 6, 7, 8].

The dependence on the the system size is deduced from $4\pi$-yields measured in central $C-C$ and $Si-Si$ collisions [9], and centrality-binned $Pb-Pb$ collisions [10, 11] at 158 AGeV at the CERN-SPS. For comparison, results from centrality-binned mid-rapidity yields from $Au-Au$ collisions at $\sqrt{s}_{NN} = 130$ GeV [12] are also shown.

The baryon chemical potential, $\mu_B$ is shown in Fig. 1. It is remarkable that $\mu_B$ shows no dependence at all on centrality both at SPS and at RHIC energies. The $C-C$ and $Si-Si$ values are consistent with those obtained in $Pb-Pb$ at the same energy. For comparison we indicate in Fig. 1 the results obtained in a comprehensive analysis of all data at CERN-SPS [13]. The freeze-out temperature, $T$, is shown in Fig. 2. It is again noticeable that $T$ shows almost no dependence on centrality both at SPS and at RHIC energies but the evidence is less pronounced than for $\mu_B$. At RHIC the evidence is compatible with a smooth increase in the temperature as the centrality increases. For comparison we indicate again the results of the comprehensive analysis of reference [13].

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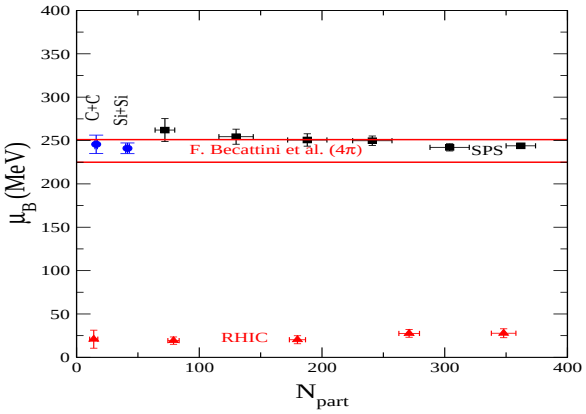


**Figure 1.** The system-size dependence of the baryon chemical potential, $\mu_B$, as extracted from centrality-binned $Pb-Pb$ [10, 11], and central $C-C$ and $Si-Si$ data [9]. Also shown are the points from RHIC [12]

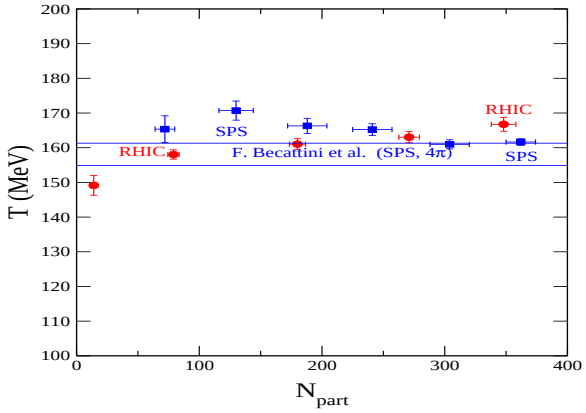


**Figure 2.** The system-size dependence of the chemical freeze-out temperature, as extracted from centrality-binned $Pb-Pb$ [10, 11] and from $Au-Au$ [12].

The clearest change in the thermodynamic parameters, as one changes the size of the system, is seen in the strangeness saturation factor [14], $\gamma_s$, which shows a smooth linear increase with centrality in the $Pb-Pb$ and $Au-Au$ system, except for the two most central bins in $Pb-Pb$ (see Fig. 1). The $C-C$ and $Si-Si$ systems lie above the trend suggested by the $Pb-Pb$ points. This clearly indicates that peripheral $Pb-Pb$ collisions are not equivalent, with respect to strangeness saturation, to central collisions

of lighter nuclei with the same participant number. At this conference first results

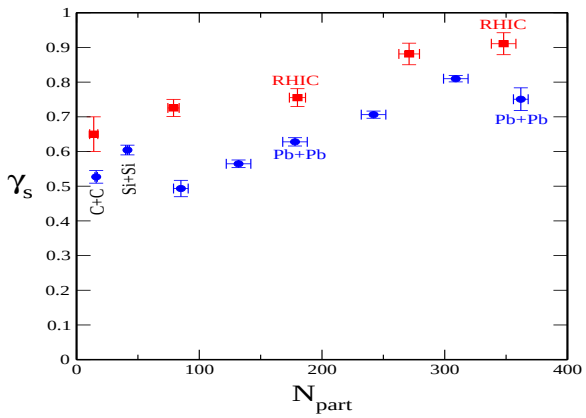


**Figure 3.** Dependence of the strangeness saturation factor $\gamma_s$ as a function of the number of participants. The lower (round) points refer to CERN-SPS at 156 GeV beam energy while the higher (square) points refer to RHIC $Au - Au$.

were presented by the E895 collaboration [16] on $\Xi$ and $\Lambda$ yields obtained in $Au - Au$ collisions at the AGS. These data require both canonical corrections and a strangeness saturation which increases linearly with the number of participants, which was taken as $\gamma_s = 0.32 + 0.0015 N_{part}$, in rough agreement with the results from SPS. The fit shown in Figs. 4, 5 uses the freeze-out temperature and chemical potential obtained from the values as determined from the fit [13].

In conclusion, the strangeness saturation factor, $\gamma_s$, increases with participant number in the $Pb - Pb$ system at the CERN SPS as well as the $Au - Au$ system at RHIC. Central collisions of $C - C$ and $Si - Si$ at SPS energies deviate, with respect to strangeness saturation, from peripheral $Pb - Pb$ collisions.

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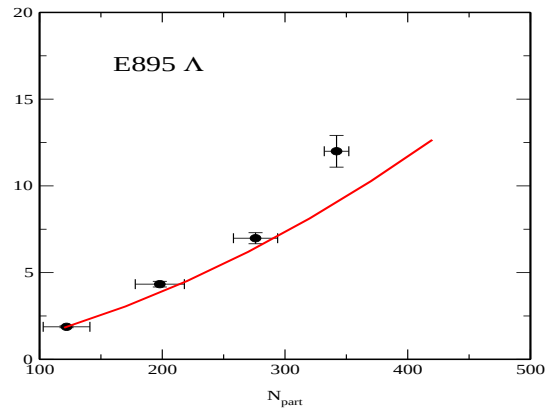


**Figure 4.** The centrality dependence of Λ as measured by the E895 collaboartion [16]. The solid line is the result of a thermal model calculation using a linearly increasing strangeness saturation factor.

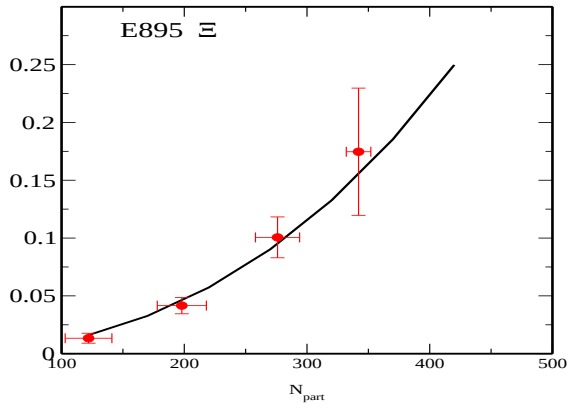


**Figure 5.** The centrality dependence of Ξ as determined by the E895 collaboration [16]. The solid line has been obtained using the same parameters is those used in Fig. 4.

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